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Lifetime Performance of the Reproductive Traits in Two Inbred Lines of Mice

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Summary

Two inbred lines of mice (C3H, DDI) were used to evaluate the lifetime performance of their reproductive traits. Females from each line were pair-mated at day 49 with males from the same line, respectively, and pairs were maintained for 210 days after mating (lifetime). In lifetime performance test, differences between the two lines were not significant except for survival rate at weaning (66.76 vs. 45.18 per cent). In the case where the effect of parities was considered, DDI was superior to C3H on number of young born (5.91 vs. 4.80), number of young born alive (5.52 vs. 4.23), body weight of alive young (8.14 vs. 6.03 g) and parturition interval (26.5 vs. 23.8 days), but DDI was lighter than C3H on body weight of dam after parturition (33.56 vs. 36.69 g). The same results were obtained on 21-day litter and average body weight.

These results showed that there was no difference between these two lines with lifetime performance because of using inbred lines of large variances in all traits. But DDI was superior to C3H in each parity on litter size, number of young born alive, litter weight at birth and weaning, and parturition interval.

Lifetime performance of breeding stock is important in the animal industry. It is known that milk production per lactation of dairy cows increases until 5th parities and decreases after that (1), and the peak of fertility is from three to six years old in cattle (2). Morever, litter size in sows decreases after 6th parities (3). However, research concerned with differences among breeds or lines of breeding stock is scarce. In the study with mice, Tomita *et al.* (4) reported on the total number of litters produced by a pair of SPF C3H during lifetime. There are some studies on lifetime performance by Roberts (5), Wallinga and Bakker (6), Bakker *et al.* (7), Nagai *et al.* (8), Schüler and Bünger (9) and, Nagai and Yokoyama (10) using selected or unselected strains.

The objectives of the present study were to compare the reproduction abilities between two inbred lines of mice and to investigate advantages or disadvantages for the mice in long-term performance on their reproductive traits.

Materials and Methods

C3H (30 pairs) and DDI (34 pairs) which are inbred lines of mice were used in this study. Males and virgin females at 49 days of age were maintained in the same cage continuously for 210 days (lifetime) when they gave birth within 50 days after the previous parturition or the first mating (day 49). At birth, litter size was not standardized, and litters were raised until day 21 in a cage with their parents, and were discarded at day 21. Throughout the experiment, a commercial pellet feed and tap water were supplied to the mice. Temperature and humidity in the mouse room were 19-25°C and about 50 per cent, respectively. The light regime was 12 hours of artificial illumination followed by 12 hours of darkness. The following traits were recorded for each pair : total number of the young born alive and dead, and litter weight (total weight of young alive in a litter) at birth, and total number of and weight of young alive at day 21.

Since total production traits (e.g. total number of young born alive during reproductive life) were influenced by line, a simple linear model may be written as follows.

$$Y_{ij} = \mu + L_i + e_{ij}$$

where

Y_{ij} = the measurement of the j th pair from the i th line,

μ = the over all mean,

L_i = the effect of the i th line,

e_{ij} = a random error with zero mean and variance, σ_e^2.

In the case where the effect of parities was considered, the least squares model described below.

$$Y_{ijk} = \mu + L_i + P_j + (LP)_{ij} + e_{ijk}$$

where

P_j = the effect of the j th parity,

$(LP)_{ij}$ = interaction.

Data of average body weight and gain at weaning were analyzed in addition to the effect of the number of young alive at weaning. LSML76 computer program (11) was used for analysis of data.

Results

The analysis of variance, and least-squares means and standard errors of total production traits at birth are presented in Tables 1 and 2, respectively. DDI tended to be superior to C3H in all traits, but the differences between them were not significant. The analysis table, and least-squares means and standard errors of total production traits at weaning are shown in Tables 3 and 4, respectively.

TABLE 1. *Mean Squares for Total Production Traits at Birth*

Source	d.f.	No. of parturition	Total no. of young born	Total no. of young alive	Total wt of young alive
Lines	1	0.064	237.161	221.161	579.801
Remainder	63	7.704	335.914	331.477	635.806

TABLE 2. *Least-squares Means and Standard Errors for Total Production Traits at Birth*

	No. of parturition	Total no. of young born	Total no. of young alive	Total wt of young alive (*g*)
C3H	4.97±0.51	27.93±3.35	25.73±3.17	36.62±4.60
DDI	5.03±0.48	31.82±3.19	29.48±3.02	42.69±4.39

(LS Mean±S.E.)

TABLE 3. *Mean Squares for Total Production Traits at Weaning*

Source	d.f.	Total no. of young alive	Total litter weight	Survival rate
Lines	1	350.269	866.232	402.824*
Remainder	63	161.684	18846.035	1061.015

Survival rate (%)=No. of born alive/No. of alive at weaning
* Significant $P<0.05$

TABLE 4. *Least-squares Means and Standard Errors for Total Production Traits at Weaning*

	Total no. of young alive	Total litter weight (*g*)	Survival rate (%)
C3H	17.40±2.21	193.10±25.06	66.76±5.95
DDI	17.88±2.21	200.52±23.90	48.18±5.67

(LS mean±S.E.)

DDI was significantly superior ($P<0.05$) to C3H in total production at birth and survival rate.

The effects of lines on litter size, number of young born alive, litter weight and parturition interval at birth, weight of dam after parturition, and litter weight, average litter weight and litter gain at weaning considering the effect of parities were all significant ($P<0.01$, 0.05) (See Table 5). C3H was heavier than DDI in weight of dam after parturition. In all traits except weight of dam after parturition, DDI was superior to C3H (Table 6).

Changes over parities on number of young born alive, weight of dam after parturition and litter weight at weaning are presented in Figures 1, 2 and 3, respectively. Number of young born alive tended to decrease with the progress of

TABLE 5. *Mean Squares of Traits at Birth (above) and at Weaning (below)*

Source	d.f.	Litter size	No.of young alive	Litter wt	Parturition interval	Wt of dam after Parturition
Lines	1	41.27**	55.14**	148.53**	230.66*	325.25**
Parities	8	29.75**	32.83**	64.66**	167.95**	306.93**
Lines ×Parities	8	5.53	8.17	20.35	102.61	32.54**
Remainder	297	5.74	7.20	14.05	53.57	6.69

Source	d.f.	Litter wt	Av. litter wt	Litter gain[a)]
Lines	1	426.61**	7.67*	406.36**
Parities	7	334.10**	11.58**	324.53**
No. alive	7	2680.42**	11.44**	1930.59**
Lines ×No. alive	7	31.82	0.69	30.75
Remainder	106	36.58	1.12	35.64

a) Litter gain (g) = Litter wt-(Average wt of young born alive × No. alive at weaning)
* Significant $P<0.05$
** Significant $P<0.01$

TABLE 6. *Least-squares Means and Standard Errors of Traits at Birth (above) and at Weaning (below)*

	Litter size	No. of young alive	Litter wt (g)	Parturition interval	Wt of dam after paturition (g)
C3H	4.80 ± 0.35	4.23 ± 0.39	6.03 ± 0.54	26.47 ± 1.05	36.69 ± 0.37
DDI	5.91 ± 0.23	5.52 ± 0.26	8.14 ± 0.36	23.83 ± 0.71	33.56 ± 0.25

	Litter wt (g)	Av.litter wt (g)	Litter gain (g)
C3H	64.21 ± 1.42	10.23 ± 0.25	54.70 ± 1.40
DDI	69.67 ± 0.96	10.96 ± 0.17	60.03 ± 0.95

(LS mean ± S.E.)

parities, and DDI was more than C3H except the 2nd parity.

Weight of dam after parturition in DDI tended to increase with parities, but that in C3H decreased after the 6th parity. Litter weight at weaning decreased with parities, and DDI was heavier than C3H in litter weight at the 1st and 4th to 7th parities.

Discussion

In the present study, since pairs which did not give birth within 50 days after the first mating (day 49) were about half of those used in the experiment, there

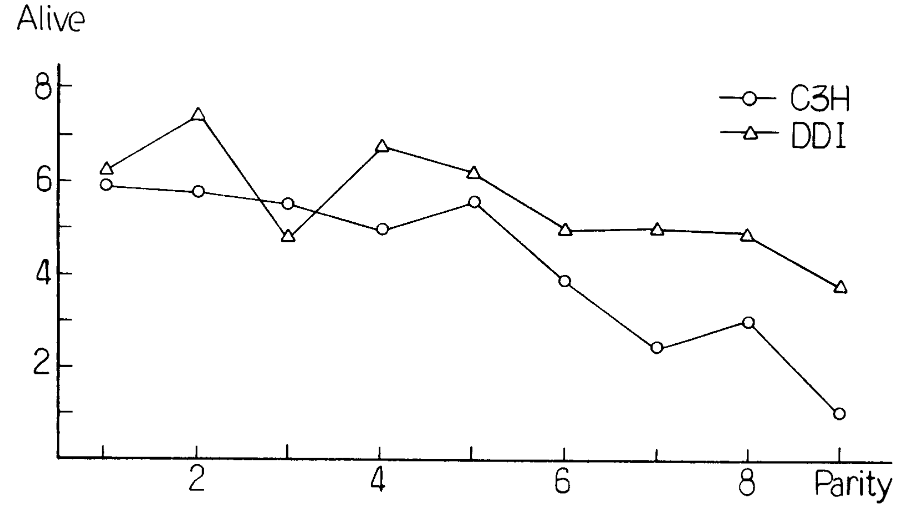

FIG. 1. Changes over parities on number born alive.

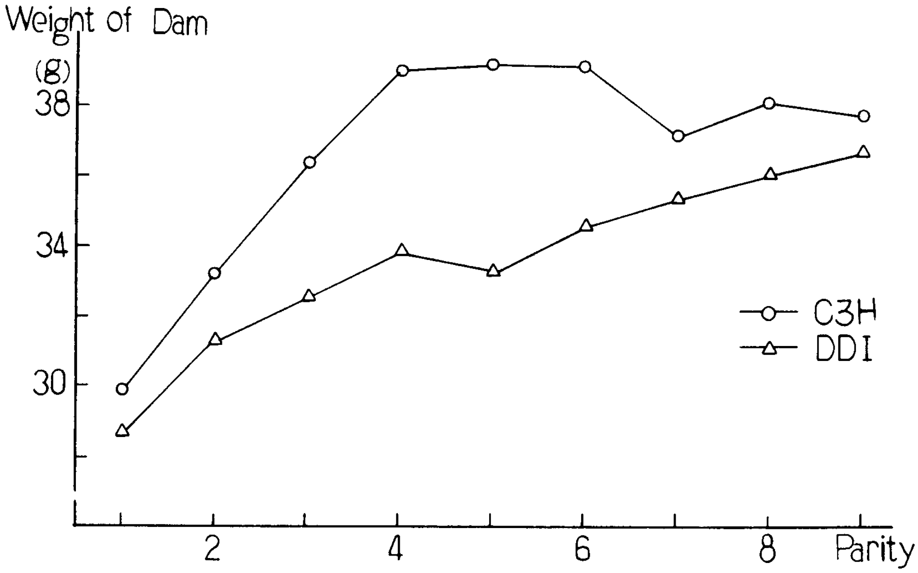

FIG. 2. Changes over parities on weight of dam after parturirion.

was a large difference between pairs which did not give birth and which gave birth to the 9th parity. A reason why line differences were of no significance in all traits except survival rate at weaning is the large variances within line in all traits. In the case of the data that excluded pairs which did not give birth within 50 days after the first mating, all traits at birth indicated significant differences between the two lines, and DDI was superior to C3H. When the comparison of long-term reproduction was examined using inbred mice which have low reproductive performance, it seems to be a disadvantage.

In the results with the effect of parities inserted, DDI exceeded C3H on the average litter weight at weaning in addition to reproductive traits (e.g. litter size). Therefore, it was suggested that DDI was superior to C3H in performance of

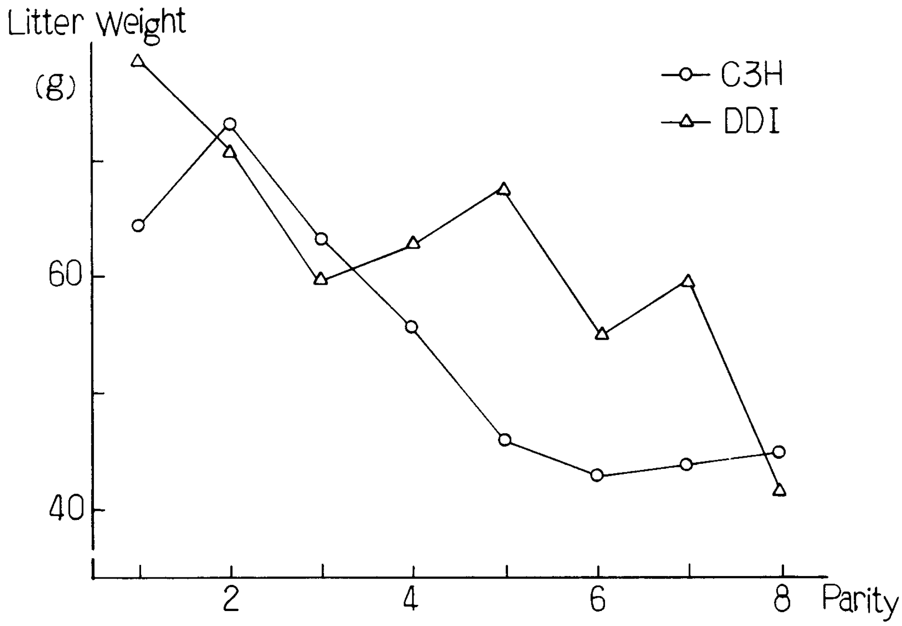

FIG. 3. Changes over parities on litter weight at weaning.

lactation and/or growth. Body weight of C3H dam after parturition was signifficantly heavier than that of DDI and this difference tended to increase with parities. Number of young born alive tended to decrease with parities. The genetic correlation between litter size and body weight is usually positive (12). But Nagai and Yokoyama (10) reported that females with small body weight after parturition showed the best reproductive performance among the six populations. Within the same line and/or the same parity, the correlation between litter size and body weight of dam after parturition seems to be high, but the correlation between those containing different lines and/or different parities may be low.

Peaks of litter size and weaning weight in mice were observed from 2nd to 5th parities (5, 8, 9, 10). But in the present study, peaks of those were in the 1st and 2nd parities because of using different inbred lines as described above.

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